FOSTERING SUPPLY CHAIN INTEGRATION THROUGH BLOCKCHAIN TECHNOLOGY: A STUDY OF MALAYSIAN MANUFACTURING SECTOR

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ABSTRACT

The study aims to identify the role of the blockchain-based supply chain in supply chain integration. The study also aims to investigate the role of various factors that possibly mediate the relationship between blockchain-based supply chain management and supply chain integration. The study adopted a twofold mixed-method approach— sequential explanatory— to attain the objectives. In the first phase, data were collected from Malaysian electrical and electronic firms, and by applying PLS-SEM, hypothesized relationships were examined. In the second phase, through a qualitative study, the results of the first phase are discussed with the industry experts to seek their expert opinion. In doing so, the semi-structured interview from seven experts, selected through purposive sampling, were conducted. The findings of both inquiries reveal that blockchain technology has significant potential to enhance the integration between numerous actors in multi-level supply chains while ensuring the transparency and traceability in the transactions. Moreover, the findings reveal that certain pre-requisites are missing at the moment in the Malaysian manufacturing sector, which are inevitable to be met, before implementing the block-chain based supply chain. Sophisticated infrastructure which could suffice the blockchain-based technologies implementation in supply chains and the absorptive capacity is prominent amongst them. Consequently, it is recommended that appropriate training should be given to employees in order to cater to the requirement of the technical skills needed to handle such advanced technology. Further, continuous infrastructural investments should be made to implement blockchain-based technology in the business ecosystem of Malaysia at the government level.

Contribution/Originality: This study contributes to the literature on BDSCM in two ways. First, taking experts from the major industries of Malaysia, this study unveils the potential of BDSCM in transmuting the efficiencies of Malaysian firms. Secondly, the study unleashes the role of BDSCM in supply chain integration.

1. INTRODUCTION

The advent of the fourth industrial revolution—Industry 4.0— is transforming the way conventional supply chains are being managed (Satoglu, Ustundag, Cevikcan, & Durmusoglu, 2018). Present, supply chains are becoming more and more complex, intertwined, and technologically oriented. It is creating greater demands on the part of supply chain management as to how to deal with increased complexity and changes in the markets. To compete effectively, the supply chains are required to be transformed by adopting digital technologies. Researchers (e.g., (Mubarik, Naghavi, & Mubarak, 2019)) claim that due to the complexity of dealing with a large number of

actors involved in the supply chain networks, contemporary supply chains have limited transparency and accountability. In this vein, the exponential increase in technological advancements in the last ten years can help to substantially improve the traceability, accountability, and verifiability of the transaction taking place in the complex supply chain networks. Likewise, digital technologies, together with big data, can be instrumental in supply chain integration, which comes through the timely generation and sharing of the information with relevant partners in the supply chain. Nevertheless, for supply chain integration, the questions of what information to share, how much to share, and to whom it should be shared are essential to be addressed. In this context, blockchain-driven supply chain management appears to be the most suitable option. It is a supply chain that unites the major developments in digital technologies, big data, and blockchain technologies under one umbrella. Blockchain is considered as one of the disruptive technologies of modern times. However, despite its heightened importance, the majority of the businesses are unsure of what blockchain is? how does it work? what fields of application the technology has? and, how their business can benefit from implementation? A common misconception is that blockchain and Bitcoin are the same things, which is not the case. Blockchain is applied for bookkeeping of the Bitcoin, which is one of the many applications for which blockchain can be used for Kranz (2018). Blockchain has the potential to be applicable in many industries, not only in the financial services industry, where most attention has been directed so far. Several industries are continuously adapting it to perform their business operations and other critical business functions like management of electronic health records, strengthening data privacy, ending counterfeiting in the supply chain (Kranz, 2018). Another important application of blockchain is the smart contract, which can operate and automate business processes in a fully decentralized way (Kranz, 2018). This, combined with the opportunity of establishing identity through the cryptographically created keys and the possibility to transfer value on the blockchain, creates the opportunity to eliminate the middleman and thereby increase efficiency (Marr, 2017). Malaysian industries, being the key players in ASEAN, are striving to adopt blockchain-driven supply chains. The 11th Malaysian plan of development also indicates to investigate the potential of new digital technologies implementations in all kinds of businesses. Digitalization in supply chain management is the potential to achieve a competitive advantage (Pflaum, Bodendorf, Prockl, & Chen, 2017). This plan also emphasizes on the identification as to how supply chain management can become more efficient and effective through increased digitalization and better information sharing. Although, the blockchain-driven supply chain is getting attention in Malaysia, the question about the potential of blockchain technology to improve the supply chain efficiency and effectiveness of Malaysian industries is yet explored (Mubarik et al., 2019). Likewise, the role of blockchain in supply chain integration and key barriers in its implementation are also to be identified in order to adopt the blockchain as the basis of supply chains of Malaysian firms. In this context, the study has two major objectives to address. The first is to identify the role of the blockchain-based supply chain in supply chain integration. The second is to identify and analyze the role of various factors that possibly mediate the relationship between blockchain based supply chain management and supply chain integration. This study attempts to address these objectives and contribute to the literature on BDSCM in three ways. First, taking experts from the major industries of Malaysia, this study unveils the potential of BDSCM in transmuting the nosiness efficiencies of Malaysian firms. Secondly, the study unleashes the role of BDSCM in supply chain integration. Thirdly, the study enumerates and explains the various challenges that firms can face while implementing the BDSCM in Malaysia. Study adopts a qualitative approach to explore the objectives.

The rest of the paper is divided into four sections. The subsequent section (section 2) briefly reviews the literature on the topic. Section 3 details the methodology adopted for exploring research objectives. Section 4 exhibits the findings of the study, and section 6 concludes the study.

2. LITERATURE REVIEW

One of the biggest changeovers in modern management was realizing that competition does not occur between individual entities, but between different supply chains (Lambert & Cooper, 2000). Companies are forced to act as fast innovators to adapt to their consumers while still competing on the three traditional dimensions, quality, time, and cost. This has made Supply Chain Management a revolutionary business model. Supply Chain Management is the design and management of the product-, information-, and value flow throughout the whole supply chain. It is a very complex business model that handles the coordination and management of all activities within a supply chain. To apply Supply Chain Management, it is essential to have a good understanding of the supply chain (Oghazi, Fakhrai Rad, Karlsson, & Haftor, 2018).

A supply chain is the network of all units that contribute to the production or delivery of a finished product to the end consumer. The typical supply chain usually consists of customers, retailers, wholesalers, manufacturers, and raw material suppliers (Chopra & Meindl, 2007). It is, however, important to recognize the big differences between different supply chains and that most generic theoretical descriptions are inaccurate in comparison to the practical supply chains. Furthermore, at first glance, it is easy to mistakenly think of the coordination within a supply chain as simple. When in reality, the coordination that has to occur is between, in some cases, hundreds of contributors, which combine into very complex networks. The goal with a supply chain is to maximize the added value. Added value is defined as the value-added in a supply chain from raw material to the finished product (Chopra & Meindl, 2007). The optimization of this process has become increasingly important, as the financial pressure put on companies has increased. In a globalized market, the competition has increased while consumers have become more demanding. Many of the functions that serve the purpose of achieving the consumer demands have shared responsibility in different processes, for example, forecasting. It is quite often here the biggest challenge with a working supply chain lies. This is because different parts of the supply chain have different goals and, in some cases, compete for the same resources. This has a negative effect on the trust and willingness to a closer co-operation (Ellinger, Keller, & Hansen, 2006; Johnson & Borger, 1977). Although companies might trust each other, they have to be able to connect somehow.

2.1. Supply chain Integration: Dimensions

In a study made by the authors (Markham & Westbrook, 2001), a closer investigation of the supplier and customer integration in 322 cases showed five different integration strategies. These strategies showed both the degree of activity as well as the direction towards suppliers and customers and are classified into the inward, periphery, supplier, customer, and outward-facing (Markham & Westbrook, 2001). As a modus operandi of the current study, supply chain integration is narrowed to customer integration, supplier-customer, and internal integration as shown in Figure 1. Also, these dimensions have been taken as our examination's fathom.
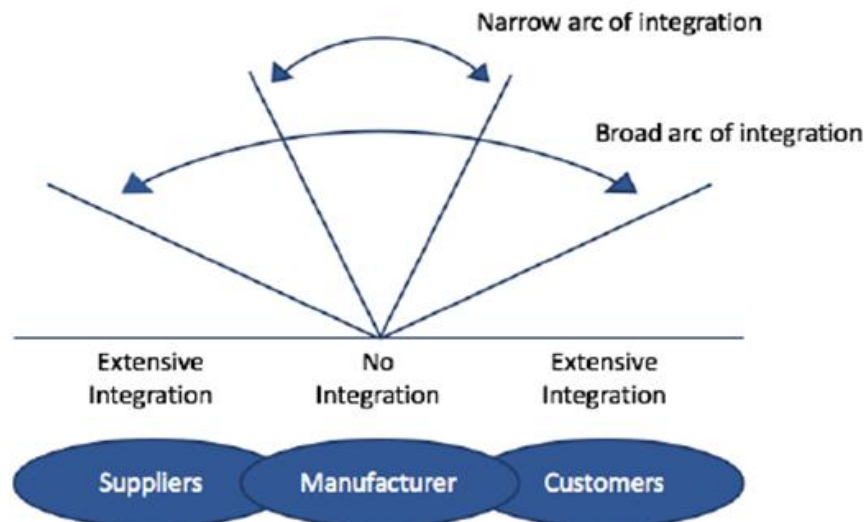
Figure-1. Dimensions of supply chain integration.

2.1.1. Internal & External Integration

Companies today face the challenge of both internal- and external integration. According to Cooper and Troyer (1995), companies have to successfully integrate on various levels of the Supply Chain to unlock the full potential of Supply Chain Management (SCM). Therefore, for a Supply Chain Integration (SCI) to succeed, both internal processes within the company as well as external processes connected with suppliers and customers have to be successful (Schoenherr & Swink, 2012). To attain the desired benefits with information sharing activities, a high level of integration is required for buyers and suppliers (Williams & Tokar, 2013).

The difficulties in quantifying the impact of supply chain integration on the performance come from unclear definitions as well as inadequate measurement tools relating to supply chain integration, performance, or both (Fabbe-Costes & Jahre, 2008). Despite the vast research within supply chain management, the definitions established are not universally accepted by all, and the measurement-scales are lackluster in construction for supply chain integration. The authors (Moyano-Fuentes, Sacristán-Díaz, & Garrido-Vega, 2016) argue that this is partially due to the inclusion of the two integration components, internal and external. This causes a problem as many definitions have a focus on one of the two. Continuing, the authors express the problematics of the variance in scope, in some cases only extending to a nearby dealer while, in other cases spreading to different levels in the supply chain. According to the same authors, this might be due to the loose definition of integration. Different authors choose to define and categorize integration differently, which creates a non-coherent perception of what metrics are included. However, a great deal of emphasis within supply chain literature is on the close unity of Supply Chain Relationship (SCR) and SCI (Tsai & Hung, 2016). Contemporary researches, like (Zhang, Guo, Huo, Zhao, & Huang, 2019; Zhu, Krikke, & Caniëls, 2018), suggested three components in integration, including internal integration, supplier integration, and customer integration.

Integration processes in a successful collaboration are required to occur both internally and externally to improve speed and safety in the whole supply chain through the blockchain technology (Pakir & Rasi, 2016).

2.1.2. Customer Integration

Collaboration and interaction amongst the firms and their customers are vital in order to enable the smooth flow of goods and services, which is termed as Customer Integration (CI). CI aims to enhance the demand-planning and the visibility in the flow of supply, without information sharing (as happens in CI), the probability of discrepancies and inadequacies may rise (Mubarik et al., 2019).

When the various information systems of customers are linked with the supplying firms, the real-time exchange of accurate information and transactions is performed, which is key to ensure the enhanced form of CI. This very phenomenon forms a seamless and invisible link amongst the various stakeholders in a business process that supports collaboration and interaction. In this era of advanced manufacturing, businesses have moved and evolved from product-orientation towards customer-orientation- customization, which can be performed only when the adequate interaction and information sharing with the customer will be done- in the form of CI.

2.1.3. Supplier Integration

In order to conduct the smooth supply of raw materials and other procurement materials, the interaction of the firm with its supplier is pivotal (Mubarik & Zuraidah, 2019; Zailani, Iranmanesh, Foroughi, Kim, & Hyun, 2019). Just like CI, a seamless and strong connection between the firm and its suppliers makes effective integration of business operations (Gilbert & Ballou, 1999; Handfield & Withers, 1993) -,, especially in manufacturing. Nevertheless, firms can achieve competitive advantage through effective collaboration and partnering with the supplier (SI), by enabling timely and accurate information sharing. It may also help to succeed in new product development strategies by changing the specifications and technology (Koufteros, Vonderembse, & Jayaram, 2005; Liker, Durward, Sobek, Ward, & Cristiano, 1996; Ragatz, Handfield, & Petersen, 2002).

Many researchers have stated integration as intra-firm integration, integration with suppliers, with the customer, with outside partners, and various (government) agencies (Mubarak, Shaikh, Mubarik, Samo, & Mastoi, 2019). Therefore, in order to integrate these all stakeholders, a sophisticated and advanced platform is required, which could undertake the complex information and transaction smoothly and effectively. Based on researchers (Kim & Laskowski, 2018; Saveen, 2016) blockchain-based technologies have the potential and capacity to carry out and handle such multi-level supply chains.

2.1.4. Information Sharing

According to Barratt and Oke (2007) information sharing is an activity that leads to more effective supply chains by providing visibility. The concept of information sharing is often divided into two different categories. The first one is tracking information regarding the merchandise. The technology used up to date has been radio frequency identification (RFID) and bar code applications. The second category is referred to as planning information and can be either demand-related or supply-related. Demand-related information shared between customers and suppliers includes customer orders, point-of-sales data, planned orders, forecasts, and available stock (Jonsson & Mattsson, 2013). In a case study conducted by Bartlett, Julien, and Baines (2007), by using transparency as a measurement of visibility, they found that the exchange of the correct information improved the supply chain performance overall. The use of external information may reduce uncertainty and improve coordination. This might be the explanation as to why externally integrated companies outperform non-integrated companies. However, Sahin and Robinson (2002) argue that information sharing in itself does not eliminate the Bullwhip effect, but that coordination among trading partners also is needed. Even further than that, according to Fawcett, Wallin, Allred, and Magnan (2009), there is a drawback with information sharing. For example, since the standard deviation of demand is higher on a daily basis in comparison to a weekly or monthly, customer integration can cause a "nervousness" that has a negative performance impact. Whereas Wu, Chuang, and Hsu (2014) examines information sharing from the perspective of social exchange theory, Fawcett et al. (2009) explain information sharing can be described as a combination of willingness and connectivity.

2.1.5. Importance of Supply Chain Relationships

For a supply chain to be successful, it takes the coordination of activities, collaboration in planning, and sharing information among the companies involved within the supply chain, so that they can improve together.

Furthermore, according to Terjesen, Patel, and Sanders (2012), the relationship aspect of SCM is the most important one since it affects all areas of the supply chain and can have a substantial impact on the performance. The author continues to argue the importance of relationship management since information technology only provides the possibility to share information, but the relationship is what drives the exchange. Managing the SCR includes managing relationships between people and issues that include respect, trust, agreements, negotiation, joint ventures, contracting, and even conflict resolution. In another study, the authors (Tan, Smith, & Saad, 2006), performed an investigation to find the main underlying factors that contribute to the management of a global supply chain from the perspective of small and medium-sized enterprises (SME). The conclusion made was that the factors are affecting SCR the most were sharing of information, expertise, trust, communication, jointly established objective and management commitment.

Studies (e.g. (S. Mubarik, Chandran, & Devadason, 2016; S. Mubarik, Warsi, Nayaz, & Malik, 2012; Terjesen et al., 2012)) divide SCR into two dimensions, scope, and criticality. The first one, scope, is the degree of responsibility assigned to the supplier. Where the relationship is defined on the basis of products/services provided by the supplier. Criticality, on the other hand, is based upon the importance provided. In literature research conducted by Hdnurkar, Rathod, and Jakhar (2016), information sharing showed to be the most important aspect of supply chain collaboration. The research reviewed 69 anonymized research papers and had a main purpose of investigating the factors affecting Supply Chain Relationships.

2.2. Blockchain Technology in Supply Chains

The technology Blockchain was first created back in 2008 when Satoshi Nakamoto, an anonymous person or group, announced the launch of the most famous cryptocurrency Bitcoin through a white paper (Nakamoto, 2008). The purpose of Bitcoin was to allow to trade true value on an open-source, decentralized ledger, without the need of a third party. The technology allowing this to happen safely is Blockchain, by recording transactions – the shared ledger – and allowing for tracking the movement of the assets. The authors, Tapscott and Tapscott (2016) of the book Blockchain Revolution describe Blockchain Technology as follows: "The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value." This is made possible due to the three technologies that Blockchain are built from:

1. *Public Key Cryptography.*
2. *P2P (Peer-to-Peer) Network.*
3. *Program (The blockchain protocol).*

The purpose of these three come from creating digital trust. A Private Key Cryptography Provides a power tool that fulfills authentication requirements while not demanding too much personal information, eliminating exposure for hackers. However, authentication is not enough to make a trade; it also requires authorization. Authorization is the process of validating that the involved parties have enough money, broadcast the correct transaction type, etc. This authorization needs a starting point in a P2P network. Finally, these transactions must occur on a secure and recordkeeping network, the Blockchain protocol (Bauerle, 2017).

2.3. Barriers in Information Sharing

In a supply chain, members are faced with obstacles in information sharing that are directly connected to connectivity and willingness. According to the authors (Lotfi, Mukhtar, Sahran, & Zadeh, 2013) some of these obstacles are, the confidentiality of the information shared, incentive issues, reliability, and cost of information technology, anti-trust regulations, the timeless and accuracy of the shared information, and finally the development of capabilities that allow companies to utilize the shared information efficiently. Further, Fawcett et al. (2009), Shahbaz, Mubarik, Mubarak, and Irshad (2019), Zameer, Wang, Yasmeen, and Mubarak (2020) and Kembro, Selviaridis, and Näslund (2014) identified: cost and complexity of implementing advanced systems and existing

systems incompatibility as barriers to better information sharing. Furthermore, Fawcett et al., (2009) add; different levels of connectivity exist up and down the chain, and *"Managers do not understand the willingness dimension of information sharing!"* as two more barriers. Kembro et al. (2014) on the other hand, adds; confidentiality of shared information and the risk of partners reaping all the benefits and the fear of becoming overly dependent on partners who receive the information as factors that may have a negative effect on information sharing in supply chains. The conceptual framework of this study is shown below in Figure 2.

3. METHODOLOGY

3.1. Quantitative Methodology

The study adopted a twofold approach. In the first phase, we employed PLS-SEM to analyze the modeled relationships. For applying PLS-SEM, data were collected from the Electrical & Electronics industry of Malaysia. Malaysia's E&E sector is one of the significant contributors to GDP and exports. The information of the E&E firms were taken from the Federation of Malaysian Manufacturing. We selected a sample of 157 for data collection.

The data was collected through a close-ended questionnaire adopted from the previous sources. All the items were measured on the Likert scale of 1-5, *1 for strongly disagree to 5 for strongly agree.* We employed PLS-SEM in two stages. In the first stage validity and reliability of the constructs were checked. In the second stage, modeled hypotheses were tested.
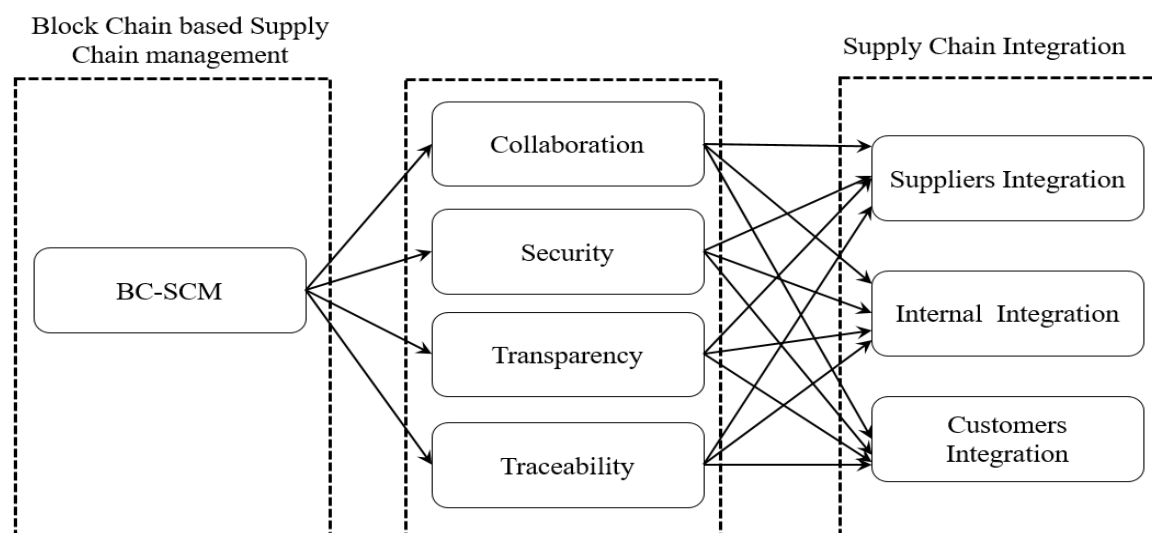

Figure-2. Conceptual framework.

3.2. Qualitative Methodology

For triangulation of the results obtained from the analysis, we adopted narrative inquiry, a type of qualitative research approach, to explore the objectives. In doing so, the study follows the interpretivism approach having a social constructionism epistemology with an inductive mind-set. The study selected seven experts from the Malaysian manufacturing sector, including electronics and engineering in. The minimum criteria for the selection of the experts were 5 years of experience of working in the supply chain domain with a position of Manager or equivalent. Semi-structured interviews of the experts were conducted. For the purpose of data analysis, a thematic approach is applied, and meaningful inferences were made.

4. FINDINGS AND DISCUSSION

In the first step, we ascertained the reliability and validity of the constructs. For checking reliability, we employed the Cronbach alpha test and composite reliability. The values of these tests, as shown in Table 1, were

higher than the threshold values of 0.70. It shows that all the constructs are reliable. Likewise, for internal consistency, the values of factor loading were checked. The factor loading values of all of the items were greater than 0.60, hence showing the internal consistency of the items. For convergent validity, the values of AVE, which should be greater than 0.50, was computed. The results show that al the constructs have AVE values greater than 0.50, hence reflecting the convergent validity. The discriminant validities of the constructs were ascertained using Fornell Larcker criteria. The results in Table 1 show that square rooted values of AVE are greater than inter-construct correlation, which proclaims discriminant validity of the constructs.

After ascertaining the reliability and validity of the constructs, we tested the hypothesis with the help of path analysis. The results alight in Table 3. The results show that blockchain-based supply chain management (BCSCM) significantly influences the collaboration which further influences the all three dimensions of supply chain integration namely suppliers integration (βeta 0.57, p<0.05), internal integration(βeta 0.37, p<0.05), and customer integration ((βeta 0.43, p<0.05). These results establish a significant mediating role of collaboration in the association between BDSCM and supply chain integration. Further, results show that BDSCM has a significant influence on security, which further influences supplier integration and internal integration. However, it does not have any influence on the customer's integration. The indirect effect of BDSCM on SI is βeta 0.23, p<0.05, and on II is βeta 0.19, p<0.05.

Table-1. Measurement model reliability and validity.

Sub-Construct	Items	λ	CB ὰ	CR	AVE
Big Data SCM	BSC1	0.71	0.77	0.94	0.54
	BSC2	0.81			
	BSC3	0.73			
	BSC4	0.72			
	BSC5	0.79			
	BSC6	0.72			
	BSC7	0.82			
Collaboration	C1	0.79	0.8	0.91	0.67
	C2	0.88			
	C3	0.82			
	C4	0.85			
	C5	0.74			
Security	S1	0.85	0.72	0.87	0.68
	S2	0.81			
	S3	0.82			
Traceability	Tr1	0.83	0.74	0.84	0.63
	Tr2	0.79			
	Tr3	0.77			
Transparency	T1	0.69	0.81	0.87	0.58
	T2	0.74			
	T3	0.81			
	T4	0.73			
	T5	0.82			
Suppier Integration	SI1	0.72	0.83	0.85	0.53
	SI2	0.74			
	SI3	0.81			
	SI4	0.66			
	SI5	0.69			
Customer Integration	CI1	0.71	0.78	0.83	0.5
	CI2	0.68			
	CI3	0.73			

	CI4	0.67			
	CI5	0.75			
	I1	0.73	0.76	0.77	0.53
	I2	0.71			
Internal Integration	I3	0.72			
	I4	0.79			
	I5	0.81			

Table-2. Fornell larcker criteria.

Construct(s)	BSC	C	CI	I	S	SI	TR	T
Big Data SCM (BSC)	*0.735*							
Collaboration (C)	0.350	*0.819*						
Customer Integration (CI)	0.410	0.370	*0.714*					
Internal Integration (I)	0.450	0.470	0.510	*0.728*				
Security	0.460	0.570	0.390	0.330	*0.825*			
Suppier Integration (SI)	0.570	0.340	0.330	0.390	0.370	*0.728*		
Traceability (TR)	0.330	0.370	0.450	0.460	0.350	0.330	*0.794*	
Transparency (T)	0.320	0.290	0.410	0.470	0.290	0.570	0.290	*0.762*

The results show that transparency mediates the association between BDSCM and supplier integration βeta 0.32, p<0.05), and customer integration (βeta 0.32, p<0.05), whereas it does not have any significant role in the association between BDSCM and internal integration (βeta 0.0.04, p=0.88). Further results show a significant mediating role of traceability in the association between BDSCM and all three dimensions of supply chain integration namely internal integration (βeta 0.24, p<0.05), customer integration (βeta 0.38, p<0.05, and supplier integration (βeta 0.18, p<0.05). Taken together, results show a profound role of BDSCM in improving security, traceability, transparency, and collaboration. Further, BDSCM, through improving security, collaboration, transparency, and traceability, improves supply chain integration. In order to discuss these results, we conducted a qualitative analysis, explained in the proceeding paragraphs.

Table-3. Hypotheses testing.

	Beta	S.E	t-value	p-value	Decision
BCSCM → Collaboration→ SI	0.57*	0.13	4.385	0.000	Relationship Exists
BCSCM → Collaboration→ II	0.37*	0.11	3.364	0.000	Relationship Exists
BCSCM → Collaboration→ CI	0.43*	0.09	4.778	0.000	Relationship Exists
BCSCM → Security → SI	0.23*	0.054	4.259	0.000	Relationship Exists
BCSCM→ Security → II	0.19*	0.082	2.317	0.001	Relationship Exists
BCSCM→ Security→ CI	0.08	0.085	0.941	0.641	No relationship
BDSCM→ Transparency → SI	0.41*	0.112	3.661	0.002	Relationship Exists
BDSCM→ Transparency → II	0.04	0.045	0.889	0.751	No relationship
BDSCM→ Transparency → CI	0.32*	0.091	3.516	0.000	Relationship Exists
BCSCM→ Traceability →SI	0.18*	0.053	3.396	0.000	Relationship Exists
BCSCM→ Traceability→ II	0.24*	0.081	3.494	0.495	No relationship
BCSCM→ Traceability→ CI	0.38*	0.142	2.676	0.001	Relationship Exists
R square	*0.512*				
Q square	*0.428*				
f-square	*0.371*				

5. DISCUSSION

To discuss the results, we undertook a qualitative approach as discussed in the methodology section. In order to undertake the interviews, we approached 45 persons from six different industries of the Malaysian manufacturing sector, including construction manufacturing concerns, metal manufacturers, motor vehicle manufacturers, electronics manufacturing concerns, engineering manufacturers, and auto parts manufacturers. Those industries are

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located in the state of Johor, state of Penang, Kuala Lumpur Federal Territory, state of Ipoh, Negeri Sembilan state, and the state of Malacca. However, only seven personnel, from seven different companies of electronics, engineering (environmental and construction), and auto parts, agreed and gave interviews. Keeping in mind the potential privacy issues, all the respondents requested not to express their identity. Interviews were conducted from a total of 07 participants from the E&E industry. Each of the experts was interviewed for 60 minutes.

After performing the interview, the detailed transcripts of all the seven interviews were prepared, and subsequently, the transcripts were analyzed and jotted down where required. Further, coding was carried out to similar opinions, and a pattern was formulated in the form of themes. In the first question, the potential of blockchain technology in the supply chain was inquired from all the respondents. As a result, seven out of seven interviewees have the same point of view that, *blockchain technology can enhance the supply chain management of their respective sectors*, and it (blockchain technology) *has a lot of potentials which needs to be tapped and applied*, in the various areas of supply chain management as previously stated by Chen (2017).

Furthermore, regarding the role of blockchain technology in supply chain integration, six respondents argued that the *amalgamation of blockchain technology would enhance the collaboration between the various stakeholders in the value chain of their supply management*. As previously confirmed by Saveen (2016) and Mubarak et al. (2019), the intra-company integration, inter-company, inter-industry, and integration with suppliers will be much better if there will be a singular platform as blockchain technology is.

Corresponding to the preceding point, it was also revealed that many people working in the Malaysian manufacturing industry have awareness about the blockchain technology and its whereabouts. Moreover, the respondents opined that as blockchain is a secure platform so the issue of security will be less as compared to conventional enterprise resource planning (ERPs) software's which they are currently using. Four respondents explicitly mentioned that, *if the transactions are transparent enough and can be tracked and traced, then the integration of the supply chain will be exemplary in our manufacturing sector*. As previously confirmed by Chen et al. (2017), Traceability and Transparency are prominent attributes of blockchain-based supply chain (Wang & Qu, 2019).

Finally, the critical barrier in implementing the blockchain technology in the supply chains was enquired. As a result, the experts commented that, *although the potentials of blockchain technology in integrating the supply chains are undoubtedly visible, certain pre-requisites are missing at the moment*, which is inevitable to adopt such sort of advanced supply chain. The fact is reported in various researches. Markedly, the absorptive capacity and the sophisticated infrastructure is missing in the Malaysia manufacturing industries to adopt blockchain-based supply chain platform.

6. CONCLUSION

With the dawn of the fourth industrial revolution, numerous areas were of the business ecosystem were identified, which are still operating in a conventional way. As a result, they are considered vulnerable to many threats, including transparency and security. Prominently the complex supply chains, which encapsulate several stakeholders, including internal (intra-company, intra-departmental) stakeholders, external stakeholders including suppliers, customers, partners, government agencies, and a few more. They are acting in the contemporary supply chains, which have become more complex and multi-echelon. Moreover, the better integration and coordination amongst all these stakeholders is inevitable in order to promote transparency, verifiability, security, and trust in the course of multiple business transactions. At the moment, a string mechanism to make this possible is missing. According to many researchers, blockchain technology has the ability of transparency, variability, and security features to manage such multi-level transactions. Therefore, this study investigated the influence of blockchain-based technology on supply chain integration in the Malaysian E&E sector through seven semi-structured interviews. As a result, it is found that a blockchain-based supply chain management system can enhance the operations of complex supply chains in the form of a distributed ledger. However, some problems in implementing such technology were also reported, which include absorptive capacity and lack of sophisticated infrastructure in the

Malaysian manufacturing sector. This study recommends that pertinent policies should be implemented at the government level to (gradually) invest on the required equipment and technologies, because the infrastructure required for these technologies is costly, and this system is required at country level or at least whole Industry (or manufacturing sector) level. Moreover, the workforce should be trained the relevant skills to handle and use that much-advanced technology.

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